B-227

grain storage

TEXAS AGRICULTURAL EXTENSION SERVICE
J. E. Hutchison, Director, College Station, Texas

grain storage reminders...

1. Any building or bin should provide:
   a. Easy access for sampling.
   b. Easy fumigation and insect control.
   c. Exclusion of birds and rodents.
2. Provide drying facilities for rice and grain sorghum or for other high-moisture grain.
   a. If natural air is used, provide 2.5 c.f.m. per bushel and do not store deeper than 8 feet during the drying period.
   b. Use only fans rated by a reputable authority (such as A. & M. College fan-testing laboratory) for drying grain.
   c. Have your air distribution system checked by an engineer for adequate distribution and against abnormal losses.
3. Be sure the building is strong enough to hold grain and that any installed drying system is adequate for *drying*.
4. Know the difference between *drying* and *aeration* when purchasing equipment.
5. Dry grain to 12 percent moisture for safe storage.

GRAIN STORAGE

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GRAIN STORAGE ON THE FARM is a common practice in Texas. Since the amount of investment in both structures and the stored product has increased over the years, careful planning is essential for a good return. This publication gives some precautions, methods and techniques to observe when providing on-farm storage.

Profits received by farmers for providing their own grain storage may vary considerably in different areas of the State. With some individuals there is little likelihood that on-farm storage will be profitable. In other cases, the extra investment and effort have paid well. An analysis of your situation and a sound estimate of the potential from such a venture should be made before building any farm grain storage facilities.

Advantages of providing your own farm storage are:

1. Ability to harvest and store at the operator's convenience.
2. Ability to store under provisions of the commodity loan program without regard to storage space shortages in the immediate area or elsewhere.
3. Ability to market for cash or through livestock at the operator's convenience and to his price advantage.

Disadvantages of providing your own farm storage are:

1. The operator assumes responsibility for maintaining the quality of grain in storage. This is important when grains are placed under the commodity loan program.
2. The farmer has an additional investment that may require considerable capital outlay in the existing farm plant, and this may be at a time when such outlay may not be desirable.
3. Normally, there is considerable additional work necessary (loading the building, fumigation, etc.) to farm-store grain properly.

GENERAL PLANNING

The farm storage may consist of a permanent building, portable bins or emergency bins. Make careful plans before any building is started, since errors in design or location can be easily corrected on paper. Changes in a partially finished or completed structure may prove expensive. Failure in the structure may be caused by improper design or lack of knowledge of materials and their strength. Be sure to make and follow a good plan, or purchase a building or bin designed to hold the grain adequately.

Plan to store your grain at a safe moisture content to avoid unnecessary losses. Nearly all storage problems trace to excess moisture, either in the grain or from outside sources such as leaks in the walls or roof.

General safe levels of moisture content for grain storage (percent)

Grain sorghums	Rice	Wheat	Shelled corn	Flaxseed	Cotton seed	Peanuts
12	12½	12	12	8.0	11-12	8.0

These are the highest levels of moisture in the bin and not average moisture content.

SIZE

It is good business to have sufficient storage capacity to store a year's crop where on-farm storage is to become a practice in the farm operation. Since grain acreage may vary from year to year, some estimating will be necessary. Multiply the average number of acres planted by the maximum yield in bushels to get the building capacity (in bushels) to construct. If drying equipment is installed, allow for space occupied by the ducts and for a maximum depth of 8 feet for the grain to be piled. (Drying of 18 to 22 percent grain is recommended only to a maximum depth of 8 feet.)

LOCATION

Locate the storage facility convenient to roads for loading and unloading the building. The facility should be near an electrical power supply for installation of drying and handling equipment. Fit it to the other buildings to avoid marring the appearance of the farmstead. If the storage is to be used in feeding livestock, plan the arrangement near the feed lot to save time and labor. Automatic handling will be a must as labor becomes more scarce in future years. Select a site which is reasonably level. There should be no low spots around or under the storage structures where water can collect. It is best not to build a granary over newly filled ground because there is danger of failure in the foundation. If such a problem is unavoidable, get a competent engineer to design the foundation properly.

Figure 1. Since moisture causes the greatest losses in stored grain, prevent entry of outside moisture. Store dry grain and keep it dry.

TYPES OF STORAGE

Most storage bins used in Texas are of the prefabricated type. Some farmers prefer to erect their own wooden or concrete buildings but increased labor costs over the past years make nearly all types competitive in total cost. Regardless of whether the structure is purchased or built from an acceptable plan, consider these factors in your selection:

1. The multiple-use, general-purpose building can be expanded if additional space is required. It can be used for other purposes when grain storage on the farm is no longer feasible. This type building usually requires erection equipment and normally is handled by a dealer or professional builder.
2. The round bin-type facility can be erected more quickly and with local labor under most conditions. Additional bins can be erected to expand storage space requirements. They normally are limited for uses other than grain storage.

MATERIALS

Steel, concrete or wood, alone or in combination, are satisfactory for constructing grain storages. The problems that are associated with each usually are traceable to misuse of the material or improper management of the storage after it is filled. Any structure must be weather-tight to keep the grain dry.

FOUNDATIONS

Grain storage foundations must support a greater weight than most farm buildings. Three general types are used most frequently — concrete slab, concrete beam (wall) and piers. For small farm-built bins, where a wall and piers are used, the footings should be of sufficient size to distribute the weight of the building over a wide area, and 18 to 24 inches high. Wood skids will support small or port-

able storages; however, they should be pressure-treated with a wood preservative.

Foundations for conventional, round-type bins may be made by setting a ring of concrete blocks and filling the inside with gravel, caliche or well-tamped earth.

In larger, flat-type structures, concrete floors generally are used and are satisfactory for grain storage. "Sweating" usually results from improper construction or inadequate ventilation of the grain. Typical concrete slab construction is shown in Figure 3. The floor thickness, size of beam and amount of steel required will depend on the grain height and the soil conditions. Have an engineer design or check your foundation plan if there is any question about it being adequate.

RODENT CONTROL

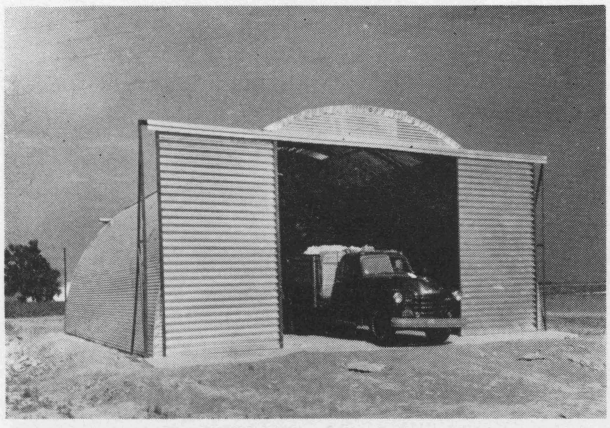
Metal or concrete structures generally are more satisfactory in controlling the entry of rats and mice. Wooden structures should have a strip of metal around the base. A control program recommended by your county agent should be followed. In all cases, keep the area around the granary free of weeds and debris.

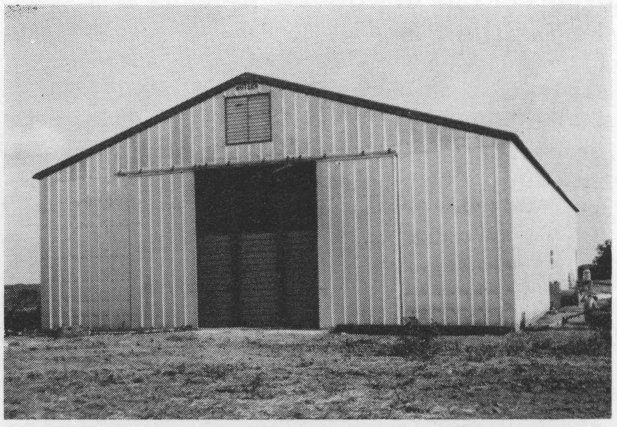
INSECTS

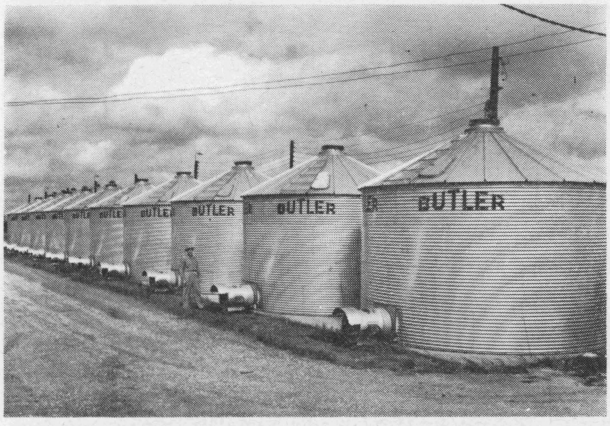
A building that is easy to clean and has the walls as air-tight as possible is desirable. This facilitates control of insects before and during storage. Fumigation of grain is necessary in most of Texas and fumigation is easier and more complete in a tightly built structure. Insect control and fumigation recommendations are available from your county agent.

DRYING AND AERATION

On-farm *drying* of grain with natural air is a common practice for grain sorghum and rice. An air-flow rate of 2.5 cubic feet of air per minute (c.f.m.) per bushel (4.5 c.f.m. per 100 pounds or 9.0 c.f.m. per barrel) is recom-







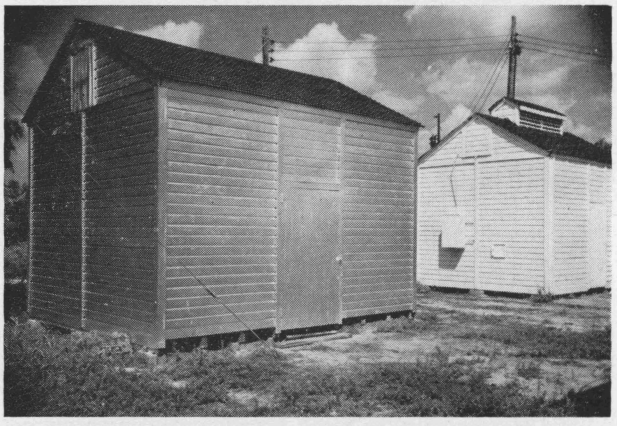


Figure 2. Typical grain storage structures. Each has functions for specific operations. Select the one that best fits your economic and capacity needs.

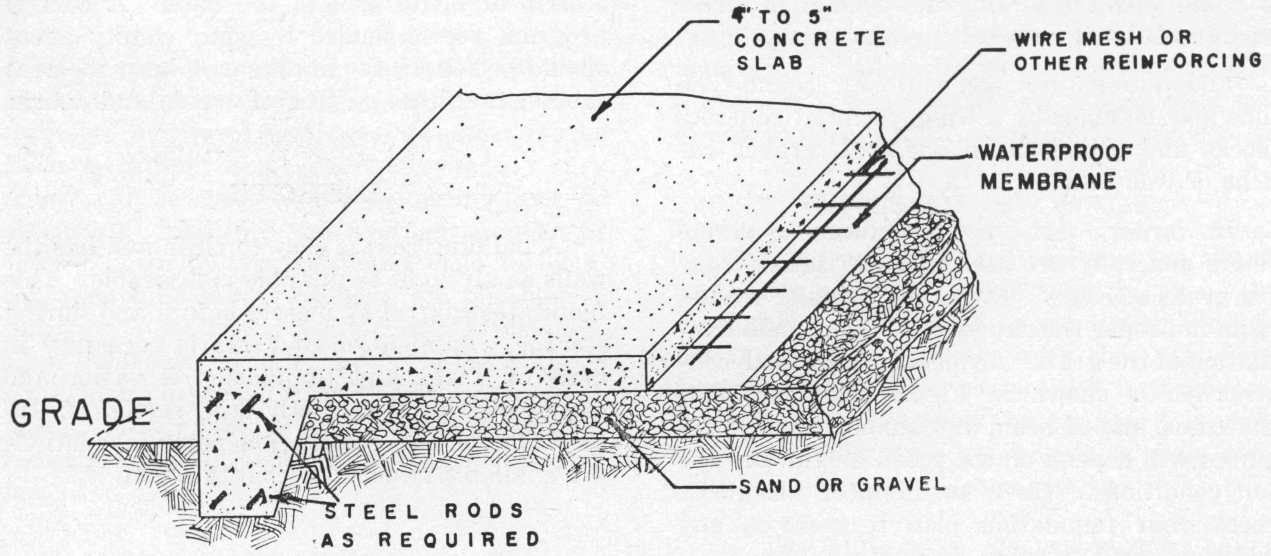


Figure 3. Typical concrete slab construction.

mended for *drying* grain in farm-type bins. This air-flow rate is based on a storage depth of 8 feet for the grain to be dried. A system that gives uniform air distribution is required. Details of this practice are available in Extension bulletin 246.

Aeration is the practice of supplying a small amount of air (.1 to .5 c.f.m. per bushel) for purposes other than drying and normally for cooling and maintaining the quality of *dry grain.* This allows the operator to keep his grain without turning it if proper management is exercised. Where drying equipment is installed in the building, the rate of cooling will be greater. Where *aeration* equipment only is installed, the rate of cooling will be slower but can be accomplished satisfactorily by following these recommendations:

Fans should be operated as often as necessary during fall and winter months to reduce the average grain temperatures below 60 degrees F. Operate the fans when the outside air temperature is 10 degrees F. or more below the temperature of the grain. Additional instructions and specific details are contained in Extension leaflet 233.

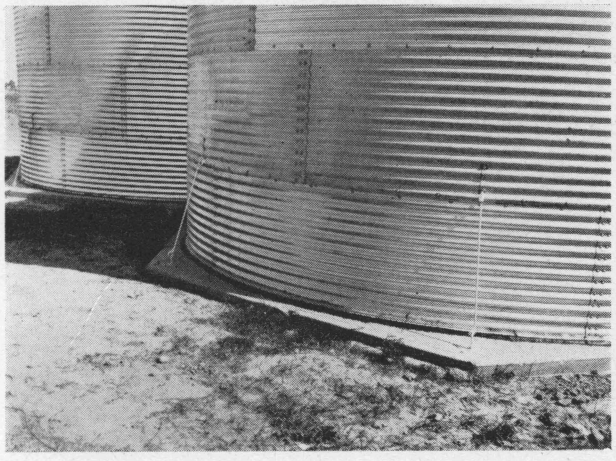


Figure 4. A concrete foundation showing a good method of anchoring the bins. Note the caulking required to prevent entry of water. Be sure adequate drainage is provided and slab is sloped so water drains properly.

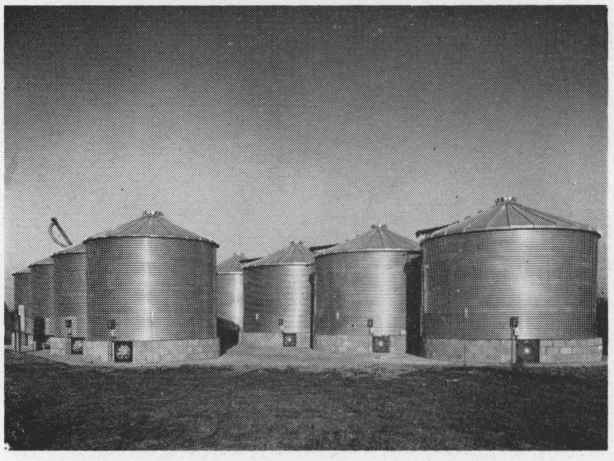


Figure 5. A group of bins on concrete block foundations. The blocks form an air chamber (plenum) for the drying system and false floors are used for the air distribution system.

HANDLING

The labor and difficulty of filling and emptying farm storage is one of the chief disadvantages of this farm enterprise. Considerable thought and care should be given to labor-saving equipment and methods to insure a profitable operation. Include a portable auger as minimum equipment and then use the suggestions shown in the accompanying photographs, if they apply to your operation.

COSTS OF CONSTRUCTION

The cost of construction will vary with the type of materials used, availability of materials, labor rate and the size of structure. For further planning, it may be noted that material costs have increased continually since 1946 and no reduction in the future is indicated.

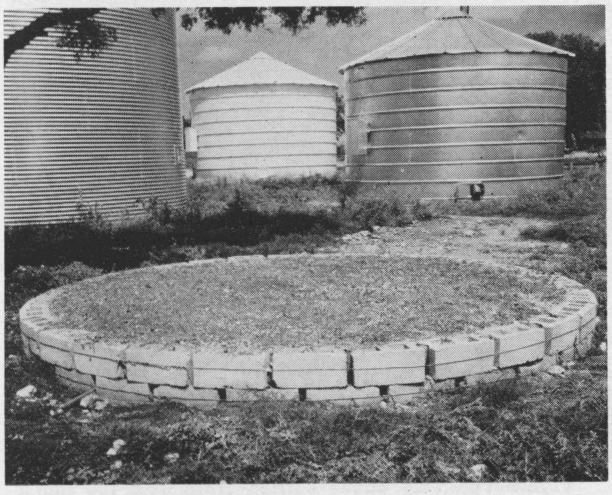


Figure 6. Other typical foundations for bins. Many use the ring type, but both offer adequate means of obtaining the required drainage.

Figure 7. Air conveyor.

The total cost per bushel of grain stored will be affected by taxes, insurance, rate of depreciation and operating costs. These costs will vary in different areas, with different kinds of grain and by the methods of handling required.

Storage facilities without drying, aeration or handling equipment will cost from 20 cents per bushel for large, multiple-use buildings, to

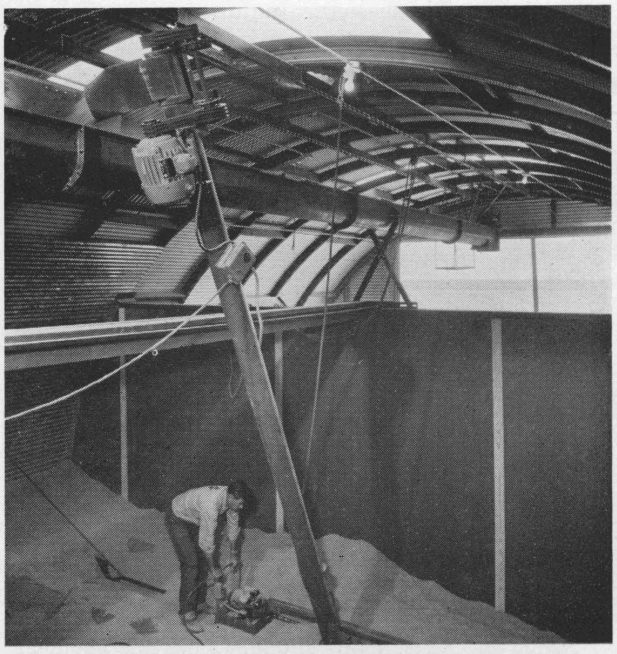


Figure 8. An overhead auger with the upright auger on a monorail is a more expensive installation but reduces labor to a minimum for a flat storage building.

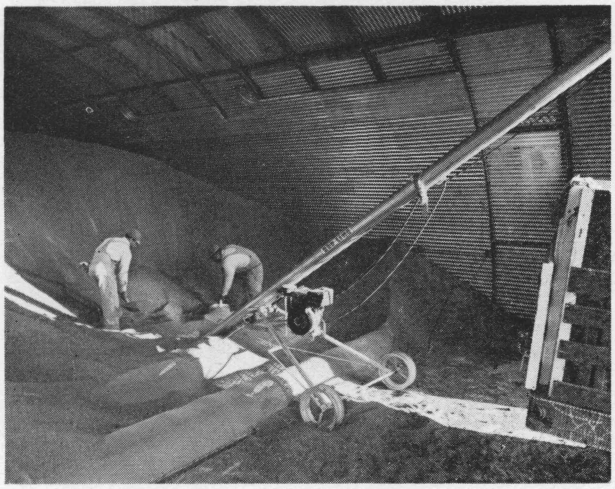


Figure 9. Removing grain from a building equipped with drying ducts. The auger can be used for filling the building and bins at harvest time.

50 cents per bushel for small bins. Cost of drying and handling equipment varies widely depending on size and the degree of automation. Usually, a drying system can be installed for 20 to 30 cents per bushel of capacity.

FINANCING

Government Facility Loan

In approved areas, the Commodity Stabilization Service of the USDA provides financial assistance in the form of loans on approved structures. These loans include up to 80 percent of the cost of the structure including the cost of conditioning equipment. The loans are for a period of 4 years, with repayment arranged so that you actually have 5 years, including the first crop year. The CSS insures the loan made by a local lending agency or makes the loan directly through the county Agricultural Stabilization Conservation office. When you apply for a loan on forms available from your local county ASC office, you must estimate the cost of the structure. The building must be one that meets the requirements for eligible storage by being constructed soundly of suitable capacity, and designed for the product to be stored. It *must be* equipped for aeration in certain areas of Texas.

Local Lending Agencies

Banks and Production Credit Associations may lend money directly or they may require the above ASC procedure approval and guarantee.

Building and Bin Dealer Finance Plans

Many of the large building and bin dealers now have financing plans of their own. Certain features vary, but generally financing to include 75 percent of the cost of the structure is available. These loans are normally repayable in 5 years or less.

A successful storage operation requires:

- **A strong, tight building.**
- **Storage of clean, dry grain.**
- **A sound insect and rodent control program.**
- **Frequent checks on moisture, temperature and condition of the grain.**

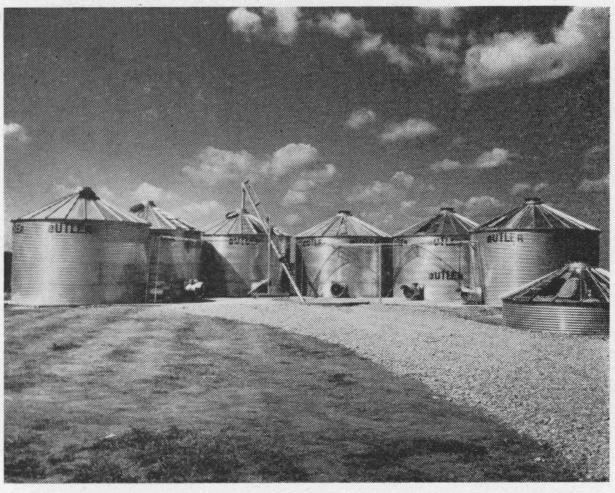


Figure 10. An elaborate arrangement of bins equipped for easy filling and unloading. The section at the right covers the pit when it is not in use. The fans can be removed to allow use of the auger in Figure 11 for unloading.

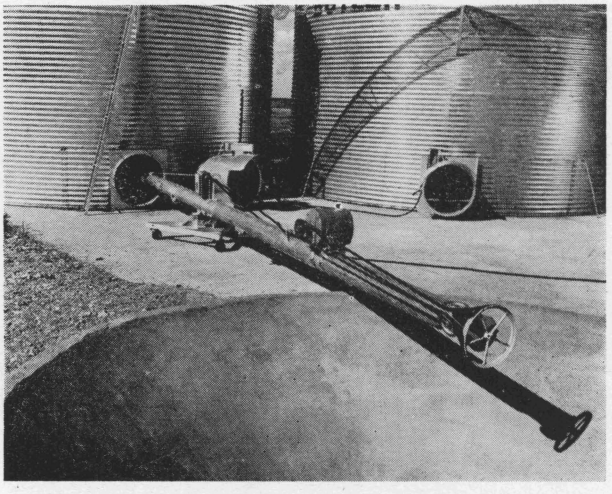


Figure 11. This auger carries grain from the bin to the pit where the large auger in Figure 10 can load the truck. One man in the bin with a sweep auger can finish the cleaning with a minimum amount of hand labor.

DESIGN OF WOODEN BINS

Some operators may desire to construct new wooden bins or remodel older buildings. Grain pressures can cause trouble if adequate size joists and studs are not used. In the absence of an engineer or designer, the following tables can be used to determine the size of these members that will carry the loads imposed by different grain depths. In the selection of spacing, make the joists and studs the same distance from center to center so that they can be tied together for greater strength, Figure 12.

TABLE 1. SAFE DEPTH OF GRAIN IN BINS WITH STUDS OF COMMON SIZES AND SPACINGS

Height of Stud (In feet)	Depth of Grain (In feet)	Size of Studs (In inches)	Spacing of Studs (In inches)
8	4	2 x 4	24
8	6	2 x 4	16
8	7	2 x 4	12
8	7	2 x 6	24
10	8	2 x 6	16
10	9	2 x 6	12

TABLE 2. SAFE FLOOR JOISTS SIZES

12 Inch Spacing Safe Depth of Grain for			Joist Size
6 foot span	7 foot span	8 foot span	
9′	4′	—	2″ x 6″
9′	8′	6′	2″ x 8″
12′	10′	8½′	2″ x 10″
16′	13′	11′	2″ x 12″
16 Inch Spacing Safe Depth of Grain for			**Joist Size**
6 foot span	7 foot span	8 foot span	
4½′	—	—	2″ x 6″
6½′	6′	4½′	2″ x 8″
9½′	8′	7½′	2″ x 10″
12′	10′	8½′	2″ x 12″
24 Inch Spacing Safe Depth of Grain for			**Joist Size**
6 foot span	7 foot span	8 foot span	
4½′	4′	3′	2″ x 8″
6′	5′	4′	2″ x 10″
8′	6½′	5′	2″ x 12″

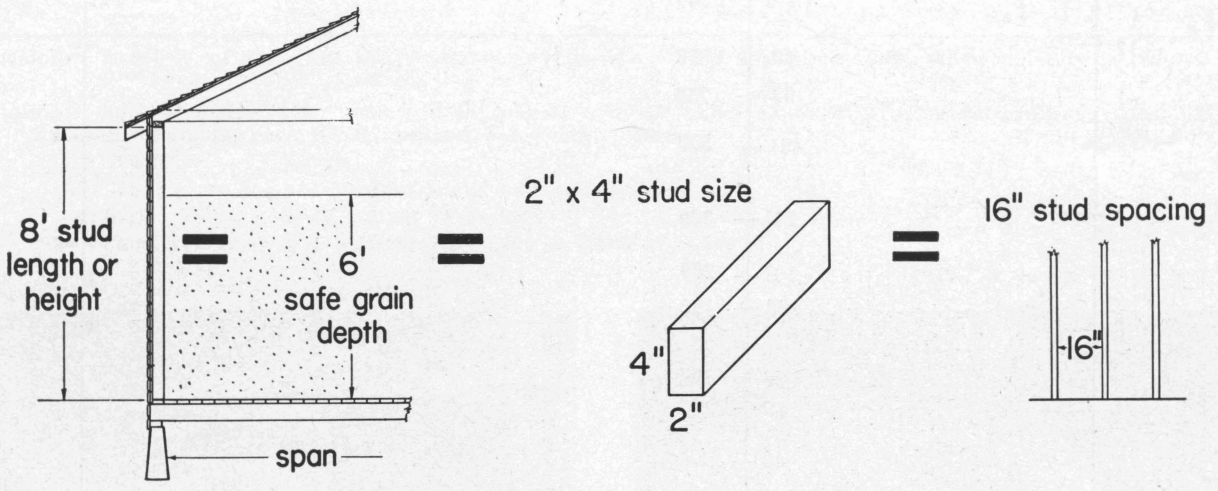


Figure 12.

CAPACITIES OF ROUND BINS

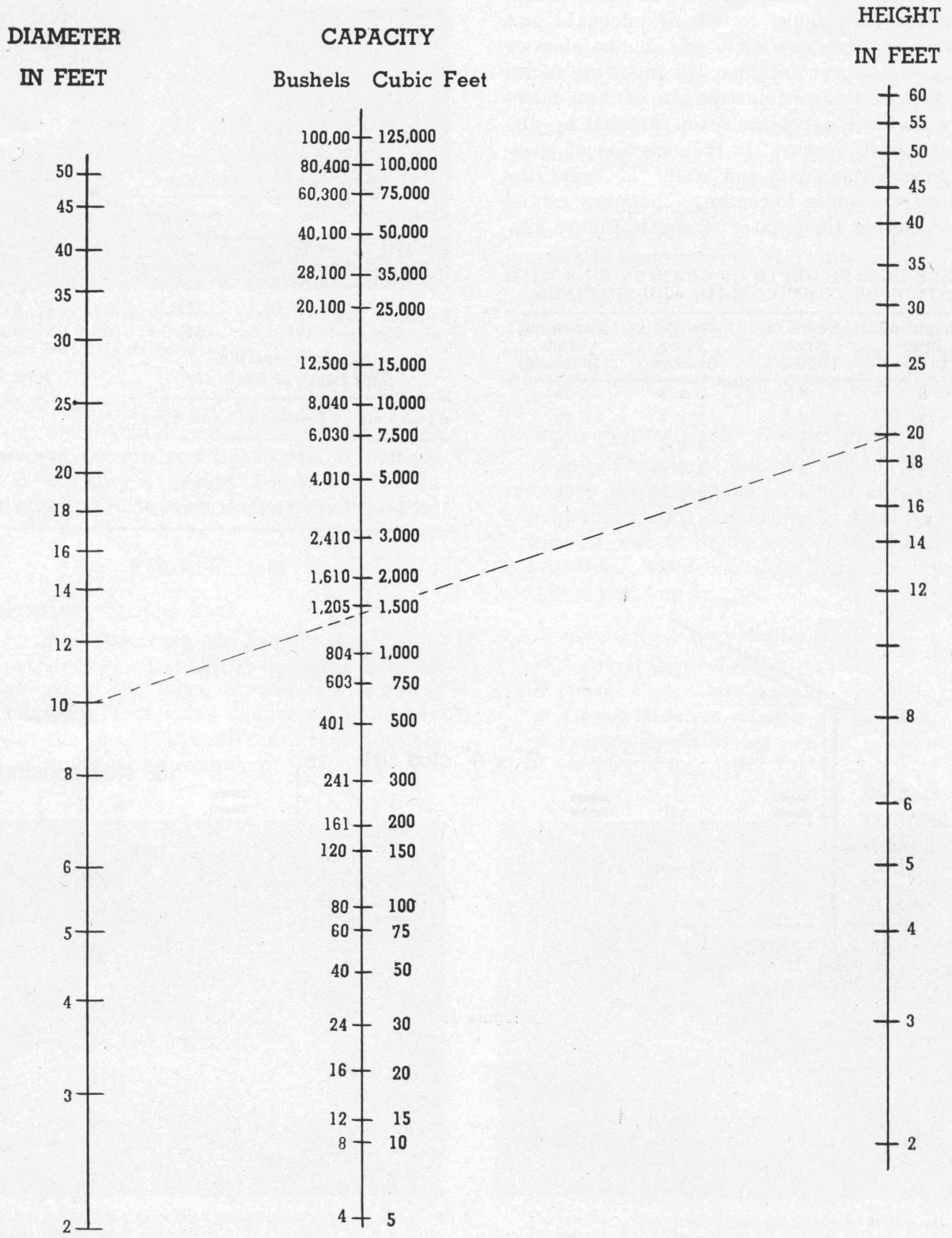


Figure 13. Lay a rule from the "diameter" line to the "height in feet" line. When it crosses the center line, read bushels or cubic feet as desired.

MISCELLANEOUS DATA

To find building capacity

Rectangular—length × width × height × .8 = bushels

Round—$\left(\frac{\text{diameter}}{2}\right)^2 \times 3.14 \times \text{height} \times .8 = \text{bushels}$

To find shrinkage losses in bushels

$$\text{Initial number of bushels} \times \frac{100 - \text{initial moisture content}}{100 - \text{final moisture}} = \text{final number of bushels}$$

TABLE 3. AMOUNT OF WEIGHT LOSS PER 100 POUNDS WET GRAIN

Final moisture content desired, percent	Original moisture content, percent															
	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
12	3.4	4.5	5.7	6.8	8.0	9.1	10.2	11.4	12.5	13.6	14.8	15.9	17.0	18.2	19.4	20.5
13	2.3	3.4	4.6	5.7	6.9	8.0	9.2	10.3	11.5	12.6	13.8	14.9	16.1	17.2	18.4	19.6
14	1.2	2.3	3.5	4.6	5.8	7.0	8.1	9.3	10.4	11.6	12.8	13.9	15.1	16.2	17.4	18.6
15	——	1.2	2.4	3.5	4.7	5.9	7.0	8.2	9.4	10.6	11.8	12.9	14.1	15.3	16.5	17.6

Example: 20,000 lb. of grain has 18% moisture (wet basis). What will grain weigh when moisture is reduced to 12%?

Solution: Looking under 18% column and opposite 12% in left hand column it is found that grain must lose 6.8 lb. in weight for each 100 lb. original wet weight. Then,

$\frac{20{,}000}{100}$ gives 200 one-hundred pound units; therefore,

200 × 6.8 = 1,360 lb. weight to be lost.

Final weight at 12% moisture = 20,000 − 1,360 = 18,640 lb.

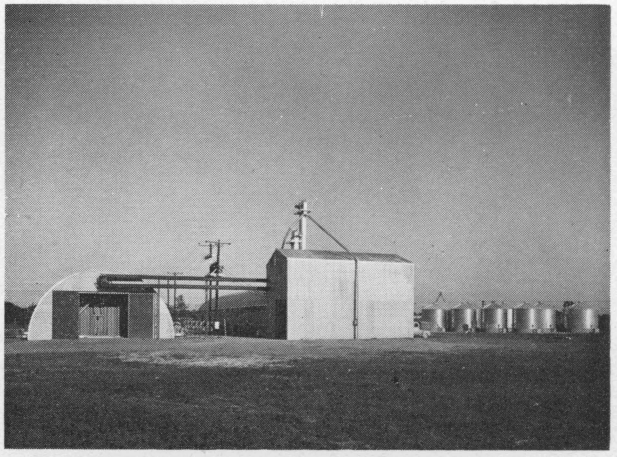


Figure 14. Supervision and quality control is equally important with the small bin or large installation found on Texas farms. Proper drying, aeration and insect control will maintain this quality and insure against the common causes of storage damage.

Have You Met . . . . . .

. . . . YOUR COUNTY EXTENSION AGENTS? If not, drop by to see them soon. They represent both the United States Department of Agriculture and The Texas A. & M. College System in your county and they can furnish the latest information on farming, ranching and homemaking.

Most county extension agents have their offices in the county courthouse or agriculture building. Get to know them and take advantage of their services.

This publication is one of many prepared by the Texas Agricultural Extension Service to present up-to-date, authoritative information, based on results of research. Extension publications are available from your local agents or from the Agricultural Information Office, College Station, Texas.

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